Sumitomo Pat App. 2002306609

[Title of the Invention] Dispensing method and apparatus of radioactive liquid

[Abstract]

[Problem] To decrease the exposure by liberating the handling person of apparatus from dispensing operation.

[Solving Means] When dispensing a required volume from a radioactive liquid 72, the dispensing amount is controlled by measuring the radioactive concentration of the radioactive liquid passing through a tube 76 composing a route of radioactive liquid.

[Claims]

1. A dispensing method of radioactive liquid characterized by controlling the dispensing amount by measuring the radioactive concentration of radioactive liquid, when dispensing a required volume from the radioactive liquid.
2. A dispensing method of radioactive liquid characterized by controlling the dispensing amount by measuring the radioactive concentration of radioactive liquid passing through a tube composing a route of radioactive liquid, when dispensing a required volume from the radioactive liquid.
3. A dispensing apparatus of radioactive liquid, being a dispensing apparatus of radioactive liquid for dispensing a required volume from radioactive liquid comprising:
   radioactive concentration detecting means for measuring the radioactive concentration of radioactive liquid, and
   means for controlling the dispensing amount on the basis of result of measurement.
4. A dispensing apparatus of radioactive liquid, being a dispensing apparatus of radioactive liquid for dispensing a required volume from radioactive liquid comprising:
   radioactive concentration detecting means for measuring the radioactive concentration of radioactive liquid passing through a tube composing a route of radioactive liquid, and
   means for controlling the dispensing amount on the basis of result of measurement.
5. A dispensing and administering method of radioactive liquid, being a dispensing and administering method of radioactive liquid for dispensing a required volume from a container of radioactive liquid and administering, comprising the steps of:
   dispensing a required volume from the container immediately before administration by a dispensing method of claim 1 or 2,

holding the whole volume of radioactive liquid right after dispensing temporarily in a radiation shielded liquid holder,

measuring the radioactivity of the radioactive liquid held in the liquid holder, and

administering the whole volume of the radioactive liquid.

6. A dispensing and administering apparatus of radioactive liquid, being a dispensing and administering apparatus of radioactive liquid for dispensing a required volume from a container of radioactive liquid and administering, comprising:

a dispensing apparatus of claim 3 or 4 for dispensing a required volume from the container immediately before administration,

a liquid holder for temporarily holding the whole volume of radioactive liquid right after dispensing,

radioactivity measuring means for measuring the radioactivity of the radioactive liquid held in the liquid holder, and

administering means for administering the whole volume of the radioactive liquid after radioactivity measurement.

7. The dispensing and administering apparatus of radioactive liquid of claim 6, further comprising radiation detecting means provided in a route of the radioactive liquid for detecting decay of radioactive concentration of the radioactive liquid or passing of the radioactive liquid.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a dispensing method and apparatus of radioactive liquid, and more particularly to a dispensing method and apparatus of radioactive liquid capable of decreasing exposure of a handling person and administering easily and repeatedly, preferably used in administration of radioactive liquid labeled with radioactive nuclide with a short half life to a subject, and a dispensing and administering method and apparatus using the same.

[0002]

[Prior Art]

In laboratories in hospitals and other institutions, when administering a radioactive

liquid labeled with radioactive nuclide with a short half life to a subject, a special mechanism is needed to prevent radioactive exposure of a handling person, and administer a specified dose accurately at a constant speed, and thus an automatic and remote-controlled apparatus is required. For this purpose, as the apparatus for automatically administering a radioactive medicine to a subject, various systems are developed, including MR contrast medium injection apparatus and radioactive liquid automatic injection apparatus.

[0003]

These injection apparatuses basically comprise a syringe filled with a specified volume of chemical liquid, a tube to a subject, a final forced injection syringe for filling the tube with distilled water for injection or physiological saline, or administering a whole volume of liquid, an automatic or manual valve for changing over the liquid flow, an operating mechanism for administering at a specified speed, a controller and others.

[0004]

By using such injection apparatus, when administering a radioactive liquid (for example, ^{18}F-FDG (fluorodeoxyglucose), ^{13}N-ammonia, ^{11}C-methionine, etc.) labeled with nuclide with a short half life (for example, as positron emission nuclide, the half life of ^{15}O is 2 minutes, that of ^{13}N is 10 minutes, that of ^{11}C is 20 minutes, and that of ^{18}F is 110 minutes) to a subject, conventionally, from a large volume of radioactive liquid, a solution was prepared in a specified radioactivity and volume for a dose of one person, and it was sucked in a syringe, the radioactivity was measured before administration, the dose was administered to the patient manually or automatically, the residual radioactivity in the syringe was measured again, the radioactivity in the administration time (reference time) was determined by radioactivity decay correction, and thus the radioactivity actually administered to the subject was measured.

[0005]

At this time, the dispensing procedure is desired to be automated and remote-controlled from the viewpoint of prevention of handling person to radioactive exposure. Various devices are available for dispensing liquid automatically, but they commonly have a problem in sterilization. Besides, it is required to calculate the amount of radioactive decay over time, and the operation is complicated.

[0006]

An automatic dispensing apparatus of medicine labeled with a nuclide with a short half

life is composed of sterile devices, and by directly reading the radioactivity, radioactivity of specified concentration is dispensed in a syringe of specified volume, and is mixed with physiological saline for dilution, and can be administered. Hitherto, this dispensing syringe was attached to an administering device not having dispensing mechanism as proposed by the present applicant formerly in Japanese unexamined patent publication No. 2000-350783. This is intended to avoid possibility of waste of radioactive liquid due to dead volume in the route.

[0007]

[Problems that the Invention Is to Solve]

According to this method, however, the syringe dispensing every time for each patient must be contained in a lead container and transported and administered to the patient, or must be attached to the apparatus, and the exposure of the handling person was increased.

[0008]

The invention is devised to solve the problems of the prior art, and it is first problem to liberate the handling person from the dispensing operation to reduce the radioactive exposure.

[0009]

It is a second problem of the invention to integrate the dispensing mechanism and administering mechanism to administer repeatedly, easily and accurately.

[0010]

[Means for Solving the Problems]

The invention has solved the first problem by controlling the dispensing amount by measuring the radioactive concentration of radioactive liquid, for example, passing through a tube composing a route of radioactive liquid, when dispensing a required volume from the radioactive liquid.

[0011]

The invention has similarly solved the first problem by presenting a dispensing apparatus of radioactive liquid for dispensing a required volume from radioactive liquid comprising radioactive concentration detecting means for measuring the radioactive concentration of radioactive liquid, for example, passing through a tube composing a route of radioactive liquid, and means for controlling the dispensing amount on the basis of

result of measurement.

[0012]

The invention has solved the second problem by presenting a dispensing and administering method of radioactive liquid for dispensing a required volume from a container of radioactive liquid and administering, comprising the steps of dispensing a required volume from the container immediately before administration by the above dispensing method, holding the whole volume of radioactive liquid right after dispensing temporarily in a radiation shielded liquid holder, measuring the radioactive concentration of the radioactive liquid held in the liquid holder, and administering the whole volume of the radioactive liquid.

[0013]

The invention has similarly solved the second problem by presenting a dispensing and administering apparatus of radioactive liquid for dispensing a required volume from a container of radioactive liquid and administering, comprising the above dispensing apparatus for dispensing a required volume from the container immediately before administration, a liquid holder for temporarily holding the whole volume of radioactive liquid right after dispensing, radioactivity measuring means for measuring the radioactivity of the radioactive liquid held in the liquid holder, and administering means for administering the whole volume of the radioactive liquid after radioactivity measurement.

[0014]

The invention further comprises radiation detecting means provided in a route of the radioactive liquid for detecting decay of radioactive concentration of the radioactive liquid or passing of the radioactive liquid, thereby minimizing the waste of radioactive liquid used for removing air from the route.

[0015]

[Embodiment of the Invention]

Referring now to the drawing, an embodiment of the invention is specifically described below.

[0016]

This embodiment an administering apparatus 20, which comprises, as shown in Fig. 1, a sterilized extension tube (or tube hereinafter) 24 having an injection needle 22 at the

leading end, for extracting physiological saline etc. for dilution from a saline bag 10 filled with physiological saline (or distilled water for injection) as proposed by the present applicant in Japanese unexamined patent publication No. 2000-350783, a saline disposable syringe (or syringe hereinafter) 28 for forced injection having a syringe drive device 30 by, for example, a pulse motor for injecting the physiological saline in the tube 24 into a tube 32 by way of three-way plug valve (or three-way plug hereinafter) 26, a three-way plug 34 for injecting a radioactive liquid into a tube 36 connected to the three-way plug 26 by way of the tube 32, a radioactivity measuring device 40 for measuring the radioactivity of radioactive liquid contained, for example, in a coil buffer loop 36A capable of holding temporarily the whole volume of radioactive liquid immediately before injection and formed in the midst of the tube 36, a three-way plug 44 for changing over the flow of radioactive liquid after measurement of radioactivity by the radioactivity measuring device 40, whether to inject to the patient or to discard, a tube 46 having an intermediate pinch valve 48 for injecting the liquid branched by the three-way plug 44 into the body of the patient by way of a final filter 50 and a winged needle 52 exchangeable for each patient, a waste liquid bottle 62 for holding the waste liquid supplied from a tube 60, being changed over by the three-way plug 44, and a controller (not shown), which further comprises a tube 76 having a catheter-run needle 74 at the leading end for dispensing a radioactive liquid from a vial 70 containing a large volume of radioactive liquid 72, for example, about 50 mCi/20 mL to 200 mCi/30 mL, a liquid syringe 82 driven by a syringe drive device 84 for injecting a required volume of radioactive liquid supplied by the tube 76 into the three-way plug 34 by way of a three-way plug 78 and tube 80, a radioactive concentration sensor 90 for dispensing and detecting presence or absence of liquid, disposed in the midst of tube 76 from the catheter-run needle 74 to the three-way plug 78, a radiation passing sensor 92 for detecting the injected volume of liquid for removing air, disposed in the midst of the tube 36 from the three-way plug 34 to the buffer loop 36A, and a radiation passing sensor 94 for detecting discharge of liquid disposed in the midst of the tube 46 from the three-way plug 44 to the pinch valve 48.

[0017]

In the drawing, reference numeral 21 is a radiation shielding partition for the entire apparatus, 41 is a radiation shield for shielding the part of the radioactivity measuring device 40 from outside, 71 is a radiation shielded container for holding the vial 70, and 83

is a radiation shield for shielding the liquid syringe 82, and all these materials are made of, for example, lead or tungsten.

[0018]

To attach the dispensing mechanism to the administering apparatus, it is required to monitor the radioactivity and volume of the radioactive liquid to be dispensed every time. By using a radioactivity detector of well-shaped ionization chamber type, the radioactivity can be monitored, but this detector is too large in size and is not proper to be assembled in the apparatus. In this embodiment, accordingly, by the radioactive concentration sensor 90, radioactivity of part of the radioactive liquid 72 contained in the tube 76 is measured, and the radioactive concentration is detected. As a result, the detector can be reduced in size and assembled in the apparatus. When measuring the radioactivity of the whole volume, due to effects of position error or residual radioactive liquid in tube, errors are likely to be included in measurement of radioactivity, and dispensing precision is not reliable, but by measuring the radioactive concentration in the tube portion, error elements are eliminated, and the volume corresponding to the desired radioactivity can be calculated from the measured radioactive concentration, so that the liquid can be dispensed accurately.

[0019]

The dispensed desired volume of radioactive liquid is entirely sent into the radioactivity measuring device 40, and an accurate radioactivity is measured, and the whole dose can be administered at a specific speed (desired speed). In the case of repeated administrations, in the conventional apparatus, the radioactivity must be dispensed every time, and the risk of exposure was high, but the invention enables to dispense and administer automatically and repeatedly at very low risk of exposure.

[0020]

The operation of the embodiment is explained.

[0021]

(1) Disposable parts (syringe, three-way plug, tube, needle, filter) which are constituent components to be exchanged at a frequency of about once a day are set in the apparatus 20.

[0022]

(2) The vial 70 containing the radioactive liquid 72 is set in the apparatus, in a state

contained in the radiation shielding container 71 exclusively furnished to the apparatus 20.

[0023]

(3) A specified amount of radioactive liquid 72 contained in the vial 70 is extracted by the liquid syringe 82 by way of the tube 76 and three-way plug 78. Consequently, by pushing in the radioactive liquid 72 until the radiation passing sensor 92 senses radioactivity by the liquid syringe 82 through the three-way plug 78, tube 80, and three-way plug 34, the route from the tube 76 to the radiation passing sensor 92 is filled with radioactive liquid, and the air is forced out of the route at the same time. To force out the air from the route is important for accurate measurement of radioactive concentration and dispensing of accurate amount, and in particular it is indispensable when administering to a human subject. Herein, the radioactive concentration sensor 90 is always measuring the radioactive concentration, and contributes to minimization of waste of radioactive liquid spent for forcing out the air from the route.

[0024]

(4) Next, using the saline syringe 28, the route from the three-way plug 26 to the tube 60 is filled with physiological saline, and at the same time the radioactive liquid used at step (3) is discharged into the waste liquid bottle 62. Further, the line from the three-way plug 44 to the winged needle 52 is filled with physiological saline, and the entire route is filled with liquid, and air is forced out.

[0025]

(5) By the controller (not shown) in the apparatus, by input of various setting conditions (radioactive dose, volume, administering speed), a necessary volume is calculated from the radioactive concentration always read in by the radioactive concentration sensor 90 and the set amount of radioactivity, the driven syringes 28, 82 and three-way plug are changed over, and the loop 36A is filled with the calculated amount of radioactive liquid.

[0026]

(6) The radioactivity of the radioactive liquid charged in the loop 36A is accurately measured by the radioactivity measuring device 40.

[0027]

(7) By operation of the controller in the apparatus, the specified volume is forced out and

injected at a specified speed.

[0028]

(8) Information of radioactivity and others of the injected radioactive liquid is printed out simultaneously with administration by a printer not shown.

[0029]

(9) The above-mentioned operation of dispensing, measuring and administering is executed repeatedly.

[0030]

It is thus possible to dispense automatically by minimizing the waste of radioactive liquid, and the handling person is liberated from the tasks of dispensing operation of radioactive liquid which is a major cause of exposure, syringe filling operation, syringe radioactivity measurement before and after filling, and administering procedure, and an outstanding effect is expected in reduction of exposure, and it is possible to administer repeatedly without exposure.

[0031]

In the embodiment, since the radiation emitted from the radioactive liquid in the buffer loop 36A of fixed shape formed in the midst of the tube 36 is measured by the radioactivity measuring device 40 inserted inside of the loop 36A, it is possible to reduce in size. The structure of the radioactivity measuring device is not limited to this type, and a radioactivity measuring device of well-shaped ionization chamber type same as in the prior art may be also used. The mechanism for forced injection of liquid or physiological saline is not limited to syringes alone.

[0032]

This apparatus is basically driven by an alternating-current power source, but when used together with a plurality of PET scanners, by assembling back-up batteries, it can be easily moved from room to room by unplugging the cord while maintaining the state of driving pulse motor and others.

[0033]

In radioactive medicine which are not so short in life, particular prevention of exposure is not so much required, and accurate measurement is not difficult, but it is evident that the invention can be similarly applied.

[0034]

[Effects of the Invention]

According to the invention, the handling person is liberated from dispensing operation, and exposure dose can be reduced. Besides, the dose of administration can be measured accurately, and repeated administrations can be done easily and accurately. Further, waste of radioactive liquid spent at the time of dispensing can be minimized.

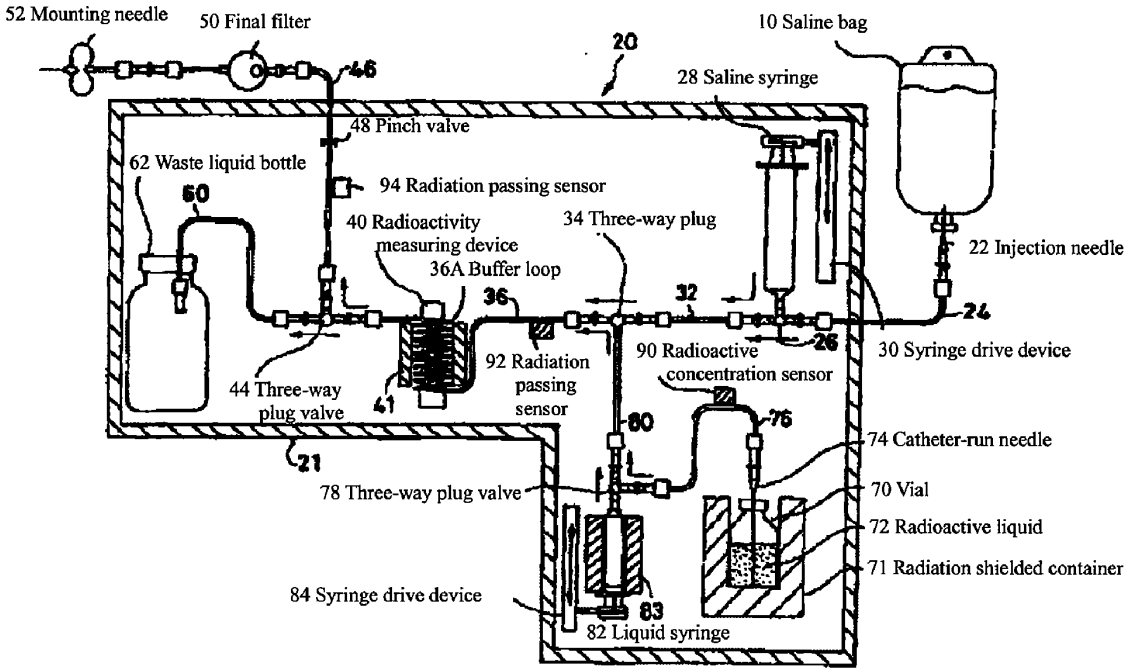
[Brief Description of the Drawing]

Fig. 1 is a piping diagram showing a system of an embodiment of the invention.

[Reference Numerals]

10 ····· Saline bag
20 ····· Dispensing and administering apparatus
21 ····· Radiation shielding partition wall
22 ····· Injection needle
24, 32, 36, 46, 60, 76, 80····· Tube
26, 34, 44, 78 ····· Three-way plug valve
28 ····· Saline syringe
30, 84 ····· Syringe drive device
36A ····· Buffer loop
40 ····· Radioactivity measuring device
41 ····· Radiation shield
52 ····· Winged needle
62 ····· Waste liquid bottle
70 ····· Vial
71 ····· Radiation shielded container
72 ····· Radioactive liquid
74 ····· Catheter-run needle
82 ····· Liquid syringe
90 ····· Radioactive concentration sensor
92, 94 ····· Radiation passing sensor

Fig. 1


52 Mounting needle
50 Final filter
46
20
10 Saline bag
28 Saline syringe
48 Pinch valve
62 Waste liquid bottle
60
94 Radiation passing sensor
40 Radioactivity measuring device
34 Three-way plug
36A Buffer loop
36
32
22 Injection needle
24
26
30 Syringe drive device
90 Radioactive concentration sensor
92 Radiation passing sensor
44 Three-way plug valve
41
80
76
74 Catheter-run needle
21
78 Three-way plug valve
70 Vial
72 Radioactive liquid
71 Radiation shielded container
84 Syringe drive device
83
82 Liquid syringe